RESEARCH PROPOSAL

QUALITY ANALYSIS OF PEELS OF SELECTED FRUITS AND VEGETABLES AND DEVLOPMENT OF VALUE ADDED PRODUCTS

For Registration to the Degree of Doctor of Philosophy

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Submitted by

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1. INTRODUCTION

Fruit and Vegetable peel wastes are typically generated from household and food-processing industries. Although the amount of these organic wastes generated from households is negligible, that generated from food-processing industries is large, as they are a major by-product in these industries. In addition, using these wastes in varied different potential applications will eradicate them from the environmental and reduce solid-waste handling, which is able to add some values to these wastes.

The production, commercialization and consumption of tropical fruits and vegetable have increased significantly in the international market due to their sensory, nutritional and therapeutic properties, however, the food industry generates high amount of residues from these fruits (Martinez *et al*. 2012 and Bicas *et al*. 2011). According to a recent survey by the Food and Agriculture Organization of the United Nations (FAO), about 1.3 billion tons of foods are wasted worldwide each year, which accounts for one third of total food industry production (Ferreira *et al*. 2015 and Gustavsson *et al*. 2011).

The use of fruit and vegetable waste recently has becoming more popular to be studied by taking into account that these residues are one of the important sources of polyphenols. Researchers become interested to study about the residue because agricultural and industrial residues are attractive source of antioxidants and dietary fiber besides reducing environmental pollution. Based on the recent studies that have been done, the peel of some fruits contain high amount of phenolic compounds and antioxidant potency. These studies indicate that fruit residue has the potential to be utilized as one of the source of bioactive compounds such as natural antioxidants.

1.1 WATERMELON

SCIENTIFIC CLASSIFICATION OF WATERMELON (Sudhaakr *et al*. 2017)

Kingdom	*Plantae*
Order	*Cucurbitales*
Family	*Cucurbitaceae*
Genus	*Citrullus*
Species	*C. Lanatus*

Watermelon (family Cucurbitaceae and species *Citrullus lanatus*) is a major fruit widely distributed in the tropics and sub tropic regions (Yamaguchi, 2006). It is one of the most important fruit crop and has large, round, oval or oblong fruit shape, the skin is smooth, with

dark green rind or sometimes pale green stripes that turn yellowish green when ripe with very rich source of vitamins (Vitamin A-590 IU, Niacin-0.2 mg/100g and Vit. C-0.7-7.0 mg/100 g), and also serves as a good source of phyto-chemicals (Perkins and Collins, 2004). It is a good source of carotenoid and lycopene. Lycopene has been found to be protective against a growing list of cancer (Cho, *et al.,* 2004), and is delectable, thirst-quencher which helps quench the inflammable that contributes to conditions like diabetes, atherosclerosis, arthritis, asthma, and colon cancer (Jian *et al.,* 2007).

1.1.1 CULTIVATION:- Watermelon is a warm seasonal crop. Optimal crop growth if temperature is above 38˚c. Optimum temperature for germination is 28-32˚C. Watermelon not only tolerates hot weather but for best growth requires more heat than any other vegetables. It requires hot dry climate and plenty of sunshine. Sandy and sandy loam soils give best growth to this crop, because loam has high yielding potential. Alluvial soil is also give more yield. The more than 500 varieties of watermelon are grown worldwide (Zohary and Hopf, 2000).

1.1.2 WATERMELON PEEL

Watermelon skin is smooth, with dark green rind or sometimes pale green stripes that turn yellowish green when ripe. It is a very rich source of vitamins and also serves as a good source of phytochemicals (Perkins-Veazie and Collin, 2004). Watermelon peel are edible and contain many hidden nutrients, but most people avoid eating them due to their unappealing flavor. They are sometimes used as a vegetable (Houqe, 2015).

Watermelon peel is a thick and firm outer coating or covering usually found in fruits like watermelon, orange etc. Watermelon peel prevents the sweeter flesh from spoiling and contains additional vitamin C, fiber, potassium and a small amount of vitamin B-6. Watermelon peel contains very few calories. Research by the Agricultural Research Service discovered that watermelon rinds contain citrulline. Citrulline creates arginine, an amino acid that makes proteins for our body and plays a role in the relaxation of our blood vessels. Some people have a natural deficiency of arginine. Watermelon peel extract is currently being studied as a possible treatment for angina and other heart and blood conditions (Pradhananga, 2017).

Table 1-Mineral composition of watermelon peel (Sudhaakr *et al*., 2017)

MINERALS	Quantity (mg/100g)
Iron	1.29
Manganese	1.42
Phosphorous	135.24
Calcium	29.15
Sodium	12.65
Copper	0.45

Zinc	1.29
Magnesium	1.48
Potassium	1.37

Table 2-Vitamins composition in watermelon peel (Sudhaakr *et al*., 2017)

Vitamins	**Quantity (mg/100g)**
Retinol (vitamin A)	52.13
Thiamine (vitamin B_1	1.23
Riboflavin (vitamin B_2)	2.71
Niacin (vitamin B_3)	4.25
Pyridoxine (vitamin B_6)	5.34
Ascorbic acid (vitamin C)	8.46

Therapeutic composition of watermelon peel

Citrulline	Citrulline is convertated in arginine its help in lower blood pressure and cardiovascular diseases (Pradhananga, 2017).
Lycopene	Lycopene is a carotenoid considered as an important fat-soluble food component with health benefits (Wang, 2007).Carotene-rich foods is associated with a lower risk of some degenerative diseases(Anese *et al*. 2013). Also lycopene may play a role specifically in preventing prostate cancer (Wertz *et al.,*2004).

1.1.3 WATERMELON PESTS AND CONTROL

PESTS	**CONTROL**
Bacterial fruit blotch of watermelon	➢ Kocide 2000 Copper hydroxide (54 percent) , ➢ Kocide 4.5 LF Copper hydroxide (38 percent) ➢ Kocide DF Copper hydroxide (61 percent) ➢ ManKocideDF Copper hydroxide (46 percent) + Mancozeb
Anthracnose of watermelon	➢ Mancozeb (Dithane M-45) ➢ Chlorothalonil (kavach) ➢ Pyraclostrobin (cabrio) ➢ Azoxystrobin (amistar) ➢ Copper hydroxide (kocide
Phytophthora root and fruit rot of watermelon	➢ Mancozeb (Dithane M-45) ➢ Fosetyl aluminium (Aliette) ➢ Azoxystrobin (amistar) ➢ Dimethomorph (Acrobat)
Pythium fruit rot	➢ Metalaxyl(Ridomil MZ gold)

	➢ Propomocarb (Previcure)
Southern blight of watermelon	➢ Carbendazim (Bavistin) ➢ Pyraclostrobin (cabrio) ➢ Tebuconozole (Folicur)
Watermelon silver mottle on watermelon	➢ Acephate (0.15%) or Monocrotophos (0.1%) ➢ Monocrotophos (0.15%), ➢ Acephate (0.15%) ➢ Neem seed kernel extract (2%)
Papaya ring spot on watermelon	➢ Acephate (0.15%) or Monocrotophos (0.1%) ➢ Monocrotophos (0.15%), Acephate (0.15%) ➢ Neem seed kernel extract (2%) ➢ Spraying imidacloprid (confidor

1.2 CUSTARD APPLE

Scientific classification of custard apple

Order	*Magnoliales*
Family	*Annonaceae* – custard apples
Genus	*Annona L.*
Species	*Annona reticulata L.* – custard apple

Custard apples are usually consumed as dessert fruit. The fruit is rich in starch when firm but increases markedly in sugar as it softens. The main sugars are glucose and fructose (80-90%). Compared with other fruits, custard apple fruits contain significant quantities of vitamin C, thiamine, potassium, magnesium and dietary fibre. The calorific value is high (300-450 kJ per 100 g) and is almost double that of peach, orange and apple (George, 2010)

1.2.1 Cultivation

There is no particular soil condition to grow custard apples. Custard apple is grown in any soil. However, must keep in mind that the soil is well drained and has good fertility otherwise it would not give a very good yield. Sandy or clayey soil is perfect for cultivate custard apple. Custard apple is a fruit of the tropical climate. Custard apple cultivate in areas with high humidity and high temperature. Frost and excessive rainfall both are harmful to the growth of custard apple trees. However, an annual rainfall of 50-80 cm is favorable for the growth of the

trees. During pollination and flowering, the temperature must remain above 25 degree Celsius. If relative humidity is low, the yield might be affected.
(*http://www.knowfarming.com/custard-apple-farming-information)*

1.2.2 Custard apple peel

Custard apple has a yellow green or brownish, thin but tough knobby skin with a yellow coloring between the nodules on the skin when fully ripen. The composition includes considerable amount of carbohydrates, small amount of protein. Low in sodium and good source of potassium, which helps to maintain normal blood pressure, reduces the risk of hypertension, transmit nerve impulses to muscles, and improves muscle contraction. It is a moderate source of minerals like calcium, iron, potassium, phosphorus, and magnesium, which play a very important role in maintaining proper metabolic activities of the body. It is also a moderate source of vitamins like thiamine, riboflavin, niacin, and Vitamin B_6, which are essential to maintain the normal activities of the body, and enhance the production of energy from the food. Moderate source of Vitamin A. Moderate source of Vitamin C, a natural water soluble antioxidant. Good source of dietary fiber (Mythily *et al*., 2012)

The peel of custard apple contains tannins, acetogenin and alkaloids which are beneficial in the treatment of several types of cancer and tumors (John *et al.*, 2017).

Therapeutic composition of custard apple peel

Phytochemicals	The phytochemicals present in custard apple peel are mainly phenolic and flavonoid compounds, which are largely responsible for antioxidant activity (Noichinda *et al.*, 2009).
Volatiles and flavour components	Several studies have reported the presence of major volatiles in custard apple fruit. These are α-pinene , β-pinene , limonene , bornyl acetate. The volatile compound found in greatest concentration in custard apple fruit is pinene, a bicyclic terpene known as a monoterpene (Bartley, 1987; Wong and Khoo, 1993; Wylie et al. 1997; Andrade et al., 2001; Rios et al. 2003; Yu, et al. 2005; Pino et al. 2006; Shashirekha, et al. 2008).
Acetogenins	The presence of acetogenins in custard apple makes it different from other fruit species (McLaughlin, 2008). The acetogenins are unique to the Annonaceous family and have considerable anti-cancer properties and anti-hypertensive activity (George, 2010)

1.2.3 Pest, Disease and their control

Pests	Control
Pseudocercospora spot	➢ Mancozeb. ➢ Copper oxychloride

Anthracnose	➢ Copper oxychloride fungicide and with Biopest oil ➢ Fungicides such as mancozeb, or Cabrio or with Biopest. ➢ Octave (prochloraz)
Purple blotch	➢ Mancozeb and copper ➢ Phosphonate and Metalaxyl- M
Diplodia rot	➢ Mancozeb
Black canker	➢ Copper and mancozeb
Cylindrocladium fruit rot	➢ regular sprays of fungicide

1.3 JACKFRUIT

Scientific classification of jackfruit

Class	Magnoliatae
Order	Urticales
Family	Moraceae
Genus	Artocarpus

Jackfruit is a dicotyledonous compound fruit of the jack tree (*Artocarpus heterophyllus* L.) which belongs to the family Moraceae grow in many of the tropical countries of Southeast Asia but is particularly abundant in India and Bangladesh. The jackfruit significantly contributes to the nutrition of the people of this country as a source of vitamins, minerals and calories. Both tender and ripe fruits as well as the seeds are rich in minerals and vitamins. The primary economic product of jackfruit is the fruit, used both when immature and when mature. The fruit pulp is sweet and tasty and used as dessert or preserved in syrup (Remme *et al*.,2013).

1.3.1 CULTIVATION :-Jack grows well and gives good yield in warm humid climate of hill slopes and hot humid climate of plains. The crop grows successfully from sea level upto an elevation of 1200 M at an optimum temperature range of 22-35oC. The yield and quality of fruits are medium under low humidity. The West coast plains with high humidity are found to be highly suitable. A deep rich alluvial or open textured loamy soil or red laterite soils with slightly acidic condition (pH 6.0 – 6.5) with good drainage is ideal for jack fruit , however, it can come up in variety of soils. (Talaulikar *et .al*.,2014).

1.3.2 JACKFRUIT PEEL

Jackfruit rinds are normally disposed as wastes by food industries and vendors. Jackfruit (*Artocarpus integer*) peel is one among the under-utilized waste substances that have potential in the manufacture of functional food additives. The average particle size and zeta potential value is (0.116μm) and (- 19.3mV). Proximate analysis showed that jackfruit peel contains the high amount of cellulose (27.75%), pectin (7.52 ± 0.12 %), protein (6.27 ± 0.03%) and starch (4%) High-Fiber Jackfruit rind (Sundarraj and Ranganathan , 2017). Jackruit rind includes perianths of unfertilised fruits, so, it is generally used to produce syrups and jellies due to its good basis of pectin. Rinds along with other waste parts of the fruits are utilized as a nourishing feed for livestock (Sudiyani *et al.,* 2002).

1.3.3 Pest, Disease and their control

Pest and disease	Control
Stem borer	➢ NSKE 5% and neem oil 0.3%
Pink Waxy Scale	➢ 2% mahua oil spray
Thrips	➢ 0.7% synthetic garlic oil
Aohid	➢ Carbaryl 0.2% or quinalphos 0.05%
Castor Capsule borner	➢ DDVP 0.05%
Anthracnose	➢ Bordeaux mixture 0.4% or copper oxy chloride 0.25%
Male inflorescence rot	➢ Carbendazin 0.1% or Thoiphonate methyl 0.2%

1.4 ASH GOURD

Scientific classification of ash gourd

Order	*Cucurbitales*
Family	*Cucurbitaceae*
Genus	*Benincasa* Savi
Species	*Benincasa hispida*

Round, grey coloured, well matured waxy fruits measures 8-12 cm in length, 3-5kg in weight and 7-10mm long seeds. The fruit is used to treat summer fever, epilepsy, lung diseases, asthma, cough and internal hemorrhage. The rind is also used to treat diabetes and seeds to expel tapeworms (http://www.indianetzone.com). The juice extracted from matured ash gourd is

effective in case of mercury poisoning and snake bites. Being extremely low in calories, ash gourd juice is also used in treating of obesity (Kapaleshwar, 2010**).**

Ash-gourd is enriched with nutrients. It is an excellent source of vitamin B_1 (thiamine) and vitamin B_3 (niacin), and vitamin C. It is also rich in calcium and potassium, It is a good vegetable for maintaining a healthy blood pressure. In Ayurveda, ash-gourd is also used to treat mental illnesses and nervous disorders such as epilepsy, paranoia, and insanity. Ash-gourd is alkaline in nature and hence has a cooling and neutralizing effect on stomach acids and as such used effectively for treating digestive ailments like hyperacidity, dyspepsia, and ulcers. It is also used to treat diabetes (Mythily *et. al*., 2012)

1.4.1 CULTIVATION

It can be grown in any type of soil but loamy to sandy loamy soil is preferred. The optimum time for sowing seeds is February to March. Plants take five months from seed to produce a mature fruits which are ready for harvest within 45 to 60 days. Matured ones coated with powdery substance are harvested between 80 and 90 days after sowing. Each plant yields nearly 50-60 fruits. A well matured, non injured ash gourd fruit has shelf life of 6 to12 months. The fruit is best kept on shelves or hung in net sacks, in a dry and cool atmosphere (Kapaleshwar, 2010)

1.4.2 ASH GOURD PEEL

The peels of ash guard are rich in sugar, protein, carbohydrates, methionine, amylose, phytate, oxalate, proline and phenolic components in large amount. Since ash gourd peels having these content can be provided as a substrate for growth of the various microorganism which can be used to produce industrially important products like enzyme i.e., Laccase, Cellulase and so,organic acid, vitamins etc., by microbial fermentation (Tiwari *et al*., 2017).

1.4.3 Pest control

Fruit fly, epilachna beetle and red pumpkin beetle are important pests affecting ash gourd. They can be controlled as given under bitter gourd. Aphids can be controlled by spraying malathion 0.05% or quinalphos 0.03%.

1.4.4 Disease control

Powdery mildew and mosaic are important diseases in ash gourd. They can be controlled as in bitter gourd. Harvesting can be done only after 10 days (at least) of insecticide / fungicide application. The fruit should be washed thoroughly in water before cooking.

2. REVIEW OF LITERTURE

2.1 Watermelon Peel

AUTHOR AND YEAR	FINDING
Mineral and Vitamin Compositions Contents in Watermelon Peel (Rind) (Sudhaakr *et al*., 2017)	➢ The mineral and vitamin compositions of the rind of watermelon (*Citrullus lanatus*) were investigated, using standard methods. in the peel, Iron 1.29, manganese 1.42, phosphorous 135.24, calcium 29.15, sodium 12.65, copper 0.45, zinc 1.29, magnesium 1.48, potassium 1.37 are presented in mg/100g ➢ Composition of vitamin composition in mg/100 g, vitamin A -52.13, vitamin B1-1.23, vitamin B2-2.71, vitamin B3- 4.25, vitamin B6- 5.34, and vitamin C-8.46. ➢ The results showed that the peel (rind) is a better source for the minerals and vitamins Phosphorous, Calcium, vitamin A and vitamin C are reported that waste material have had valuable contents it may be of nutritional and physiological importance.
Utilization of Watermelon Rind (Byproduct) in Preparation of Candy and its Quality Evaluation (Dhakal and Pradhananga,2017)	➢ The study was carried out for the utilization of watermelon rind in candy preparation using different pre-treatment and syrup. ➢ Watermelon rind can also be used in making candy as byproduct utilization which could generate the income too. ➢ Honey incorporated candy in the ratio 25% with sucrose of acceptable sensory and phyiso chemical characteristics can be developed and the product B (25 honey: 75 sucrose) in 1000g watermelon rind was best, based on sensory attributes.
Drying of Watermelon Rind and Development of Cakes from Rind Powder (Hoque and Iqbal ., 2015)	➢ This study reports on the possibility of value addition to watermelon rinds by processing of cakes using watermelon rind flour with wheat flour. ➢ The properties of the cakes were evaluated in terms of volume, moisture content, crumb and crust characteristics etc. ➢ The overall crust characteristics of 10.0% watermelon rind powder cake seemed to be better than the other samples. ➢ On the basis of physic-chemical properties and organoleptic evaluation of the processed cakes, it may be concluded that good quality watermelon rind powder cake may be processed incorporating 10.0% watermelon rind powder into the formulation of plain cake for improved nutritional value and other aspects.

Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake (Sayed and Ahmed., 2013)	➢ Watermelon rinds showed significantly greater free radical scavenging activity and b-carotene (39.7% and 96.44%), respectively compared to sharlyn melon peels. ➢ It contained different types of phenolic compounds, the most abundant one was 4-hydroxybenzoic acid (958.3 lg/g dw) followed by vanillin (851.8 lg/g dw). ➢ Watermelon rind and sharlyn melon peel were good in antioxidant activity to increase shelf-life of cake. Substitution of wheat flour at 5% is recommended to produce an acceptable cake. ➢ Overall, it could be recommended that the technology of using watermelon rind and sharlyn melon peel powders should be encouraged among food industries to make economic use of local raw materials to incorporate into cake and provide cake with more functional components and more effective antioxidant activity.
Effective jam preparations from watermelon waste (Jamal *et al* **.,** 2012)	➢ Jam is an agglomeration of fruit pulp and sugar at definite proportions. ➢ Its characteristic chemical, taste, colour and texture properties are paramount and expected to be stable over the shelf for so time after first opening. ➢ Result showed that the sample with 50% WMR and 50% sugar gave desirable properties by maintaining the light green colour. ➢ Equal proportion of rind and sugar gave is necessary for acceptable result in gel, soluble sugar stability, ascorbic acid and pH.

2.2 Custard Apple Peel

AUTHOR AND YEAR	FINDING
Investigation on the Antimicrobial and Antioxidant Activity of Custard Apple (*Annona reticulata*) Peel Extracts(John *et al .,* 2018)	➢ *Annona reticulate* peels investigated for phytochemical components appeared to have the properties of a nutraceutical and improve the health status of the consumers when consumed regularly. ➢ Drug resistance microbes are gaining resistance day by day towards the antibiotics and fruitpeels of *Annona reticulata* could be used as a source for antibiotic toovercome antibiotic resistant organisms as plant foods can be consumed without the fear of adverse effects. ➢ Fruit peel extracts possesses antioxidant and antimicrobial properties, and is therefore a potential

	source of ingredients for the food and pharmaceutical industry.
Total Phenol and Antioxidant from Seed and Peel of Ripe and Unripe of Indonesian Sugar Apple (*Annona squamosa* L.)Extracted with Various Solvents (Setyadjit *et al* ., 2015)	➢ Study on total phenol and antioxidant activity of sugar apple fruits of various solvent, part of fruits, and level of ripening. ➢ This fruit has a few amino acids such as arginine, glutamine, serine, isoleucine, leucine, methionine, phenylalanine, tyrosine, and tryptophan. ➢ Bark of sugar apple has phytochemical compounds such as alkaloid, tannin, protein, saponin, phenolic compound etc. These compounds have antioxidant activity that scavenging free radical and important for pharmacology.
Proximate Analysis of Peel and Seed of *Annona Squamosa* (Custard Apple) Fruit(Prajakta *et al* .,2013)	➢ Results obtained showed that the peel contained 4.08% foreign organic matter, 3.94% total ash content, 1.90% acid-insoluble ash content, 8.18% water soluble ash and 3.73%. Moisture content by Karl Fischer Method and 3.96% by loss on drying method.
Qualitative chromatographic analysis of sugars present in non edible rind portion of custard apple (Annona *Squamosa. L)* (Mythily *et al* ., 2012)	➢ This study was carried out to explore the sugar components of custard apple peels with a view to establishing their raw material potentials. ➢ The various standard sugars were spotted using the solvent system n-butanol - acetone - diethylamine - water (10:10:2:6, v/v) in the cellulose layer or TLC analysis indicated the presence of lactose, sucrose, galactose and glucose. ➢ The array of sugar contents of custard apple peel were extracted, it will amount to huge economic waste to consider these peels as waste garbage meant only for the waste bin. ➢ Therefore, there is need to explore ways of reducing the environmental menace that may arise from huge seethapal peel wastes.

2.3 Jackfruit peel

AUTHOR AND YEAR	FINDING
Physicochemical characterization of Jackfruit (*Artocarpus integer* Thumb.).) Peel. (Sundarraj and Ranganathan , 2017)	➢ Proximate analysis showed that jackfruit peel contains the high amount of cellulose (27.75%), pectin (7.52 ± 0.12 %), protein (6.27 ± 0.03%) and starch (4%). ➢ From the results obtained, it can be concluded that Jackfruit peels of *Artocarpus* can be utilized as a potential source for extraction of valuable ingredients

	such as cellulose and low methoxyl pectin for application in functional and therapeutic foods and health product, so proving to be a financially viable different to waste utilization and environmental protection.
Utilization of jackfruit (*artocarpus heterophyllus lam.*) rind powder as value added ingredient in bread(Feili ., 2014)	➢ Utilization of Jackfruit rind powder (JRP) is an environment friendly technology since it could solve the waste disposal problem of residues. ➢ High-Fiber Jackfruit rind powder as food supplement/additive in breads and cookies can be used as fiber food to help preventing constipation. ➢ It can be used as well as fiber food for patients with diabetes and moderately raised cholesterol levels. It consists of 60% dietary fiber (56% insoluble and 4% soluble).
Physical and Sensory Analysis of High Fiber Bread Incorporated with Jackfruit Rind Flour (Zzaman *et al* .,2013)	➢ Jackfruit rind flour (JRF) was incorporated into wheat flour (WF) in three different ratio (5, 10 and 15%) to produce partially substituted wheat flour (WF) with JRF. ➢ The incorporation of JRF caused significant influence on bread volume and texture attributes. ➢ Bread samples substituted with 5% JRF had the highest mean scores of overall acceptance. ➢ Higher content of crude fiber in JRF shows that it has the potential to be applied as a high fiber source in bakery products

2.4 ASH GOURD PEEL

AUTHOR AND YEAR	FINDING
Optimization for Production and Partial Purification of Laccase from Ash Gourd Peels (Tiwari *et .al.,*2017)	➢ Peels of Ash Gourd is rich in various nutritional substances which are required for culture of microorganisms. By estimating proximate values of various substances a synthetic media was prepared for *Trichoderma Viride. Laccases* were collected extra and intracellular level . ➢ The result of the analysis shows that were moisture content-92.4%, ash-1.6%, protein-12.7%, crude fibre-11%, crude fat-5.5%, total soluble sugar- 30%, reducing sugar- 0.002%, total phenol-1.84mg/ml, carbohydrate 0.27-µg/ml, amylase-0.36%, maltose-0.009%, cellulose-0.45mg/ml, proline-0.5µg/ml, methionine-6.0mg/g, ascorbic acid-138.6mg/ml, oxalate-2.49 mg/g., respectively. Earlier these findings were reported by Zoya *et al., (2014).*

Extraction And Mass Characterization Of Sugars From Ash Gourd Peels (*Benincasa Hispida*)(Mythily *et al* ., 2012)	➢ The various standard sugars were spotted using the solvent system n-butanol-acetone-pyridine-water (10:10:5:5, v/v/v/v) in the cellulose layer for TLC analysis which indicated the presence of Galactose, Glucose, Xylose, Sorbose.

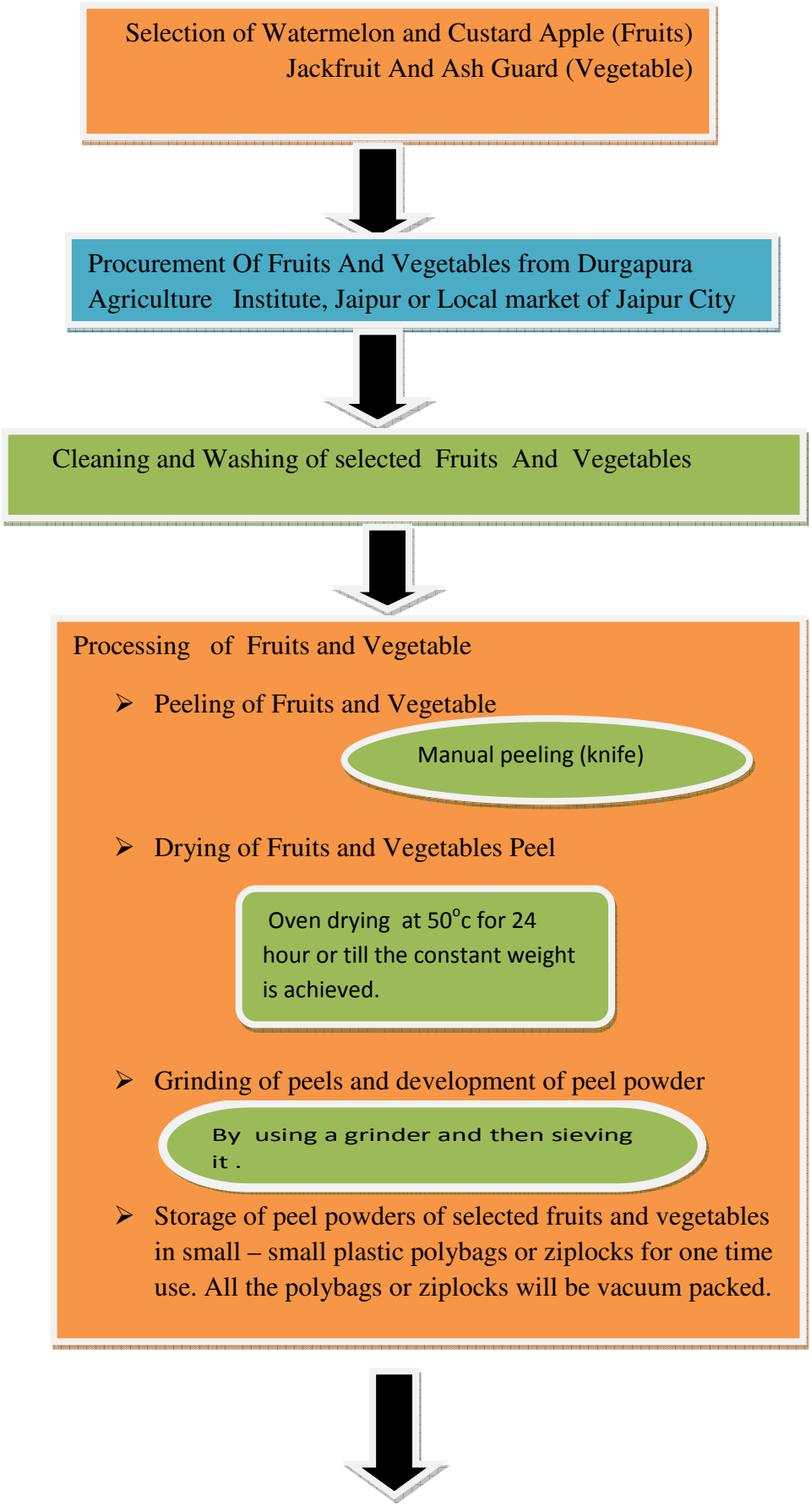
3. SIGNIFICANCE OF THE STUDY

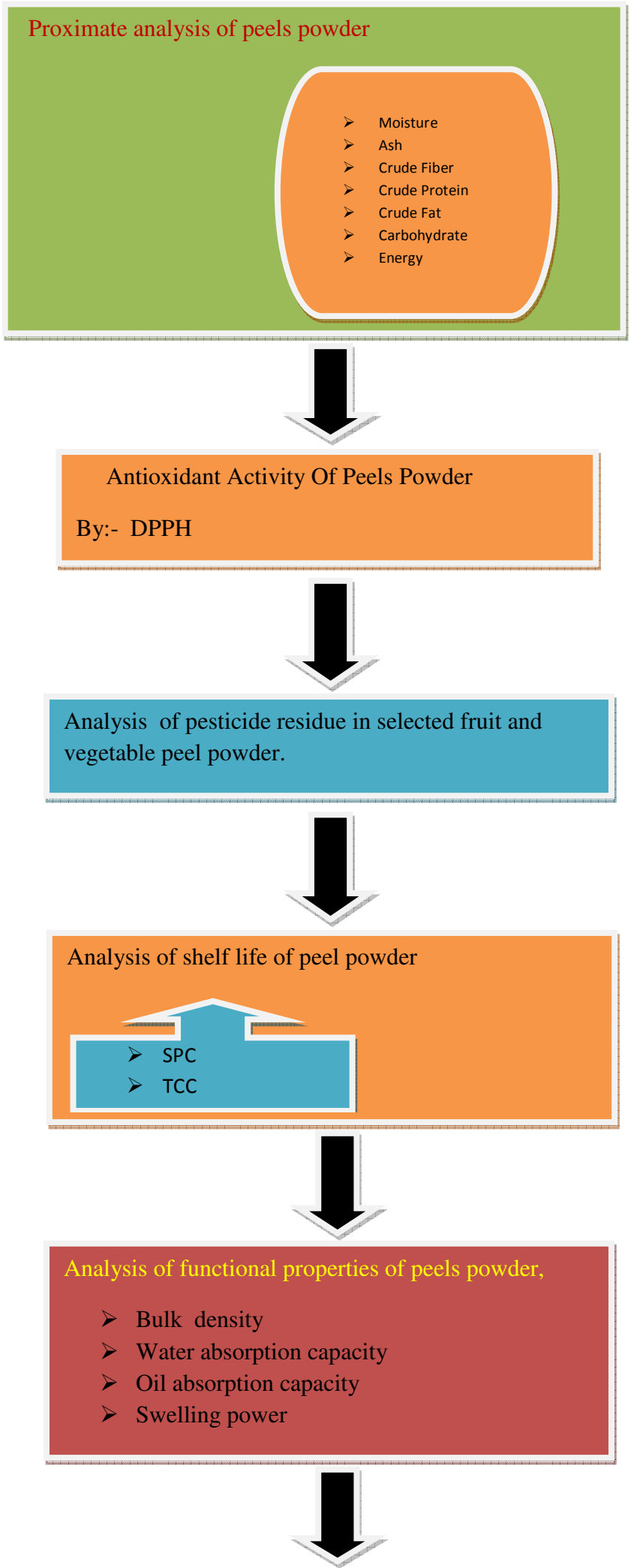
- By-product utilization will serve the twin purpose of environmental protection and value addition.
- The peels of various fruit and vegetables, which are waste products in fruit and vegetable industry, may be a potential source of antioxidants and strong antimicrobial agent.
- The natural bioactive compounds in fruits such as carotenoids, quercetin derivatives, phenolic acid and anthocyanins are found in the peels in higher concentration then flesh.
- Fruit and vegetable peel is rich in abundant chemical constituents such as pigments (chlorophyll, carotene, anthocyanin etc.), nutrients (vitamins, minerals, water, sugar, fat, protein, etc.), flavor (acid, tannins, glycosides, etc.), construction material (the glue material, cellulose, etc.), so the fruit peel has rich nutritional value.
- Peels of fruits and vegetable can be used as a source of value added ingredient in formulation of healthly food products.
- Peels of fruit and vegetable source of natural antimicrobials may provide alternatives to the food industry as it enables the replacement of synthetic preservatives by natural compounds, as well as the disposal of by-products and reduced environmental impact.
- Fruit and vegetable peel are also a strong source of dietary fiber.
- Potential source of ingredients for the food and pharmaceutical industry.

4. OBJECTIVES OF THE STUDY

1.	To analyze the proximate composition of selected fruits and vegetables peel.
2.	To assess the antioxidant activity of selected fruit and vegetable peels powder.
3.	To analyze the pesticide residues in selected fruit and vegetable peels.
4.	To assess the shelf life of selected fruit and vegetable peels powder.
5.	To analyze the functional properties of selected fruit and vegetable peel powder.
6.	To develop value added products from selected fruit and vegetable peels powdered.
7.	To do the sensory evaluation of developed products.
8.	To do the cost analysis of developed value added products.

5. Research Design


Selection of Watermelon and Custard Apple (Fruits)
Jackfruit And Ash Guard (Vegetable)
Procurement Of Fruits And Vegetables from Durgapura Agriculture Institute, Jaipur or Local market of Jaipur City
Cleaning and Washing of selected Fruits And Vegetables
Processing of Fruits and Vegetable
Peeling of Fruits and Vegetable
Manual peeling (knife)
Drying of Fruits and Vegetables Peel
Oven drying at 50°c for 24 hour or till the constant weight is achieved.
Grinding of peels and development of peel powder
By using a grinder and then sieving it .
Storage of peel powders of selected fruits and vegetables in small – small plastic polybags or ziplocks for one time use. All the polybags or ziplocks will be vacuum packed.


Proximate analysis of peels powder
Moisture
Ash
Crude Fiber
Crude Protein
Crude Fat
Carbohydrate
Energy
Antioxidant Activity Of Peels Powder
By:- DPPH
Analysis of pesticide residue in selected fruit and vegetable peel powder.
Analysis of shelf life of peel powder
SPC
TCC
Analysis of functional properties of peels powder,
Bulk density
Water absorption capacity
Oil absorption capacity
Swelling power

Development of value added food products for all age group by incorporating the developed peels powder of each fruit and vegetable in different proportions

- Baked *Chakli*
- Baked *Papdis*

Sensory Evaluation of Developed Product

- Selection of panelist (by Sensitivity Threshold test)
- Hedonic scale test

Antioxidant activity of developed product

By:- DPPH

Cost Analysis of Developed Product.

6. PLAN OF WORK-

The experiment will be carried out in a research laboratory of Department of Home Science (Foods and Nutrition), The IIS University Jaipur.

PHASE 1	Procurement and processing of selected fruits and vegetable peels and development of powder
PHASE 2	Quality analysis of all the peel powder (Proximate composition, Antioxidant Activity, Pesticide Residues, Shelf Life & Functional properties).
PHASE 3	Development of value added products by using peels powder and the Sensory evaluation of the developed products. Analysis of antioxidant activity of highly acceptable developed products.
PHASE 4	Cost analysis of developed product.

PHASE 1:- Procurement of Material

In the present study, the peels of 2 fruits and 2 vegetables will be selected. Both fruits and vegetables will be procured from Durgapura Agricultural Institute, Jaipur.

1.1 Varieties used will be -

Watermelon – *Durgapura Kesar*

Custard apple –*Saraswati Sevan*

Jackfruit – *Koozha*

Ash gourd **–** *Kashi Ujawal*

1.2 Cleaning and Preparation of fruits and vegetable peels

Watermelon peel:-The watermelon will be thoroughly washed to remove sand particles thereafter it will be sliced using knife. The pulp will be carefully scraped off to obtain the peel (Sudhaakr *et al*., 2017). Peel will be cut into pieces of approx 2×2 cm. The peel pieces will be blanched at 90˚C for 5 minutes and then dried (Dhakal and Pradhananga, 2017).

Custard apple peel: - The fruits will be thoroughly washed and separated from pulp. The peel will be collected and steam blanched for 5mins to inactivate the polyphenoloxidase enzyme. Then the peel will be cut in to pieces approx 2×2cm then dried (Roy and Sasikals, 2016).

Jackfruit peel: - jackfruit will be wash with running tap water and cut in to pieces and separate the peels and cut in to approx 2×2cm. Peel pieces will be washed by potable water and soaked in boiling water for 10 min to soften the texture and then rinsed. Thereafter, the pieces will be soaked in a boiling solution of 0.1% w/v sodium bisulfate ($NaHSO_3$) for 10 min followed by

rinsing. Pieces of jackfruit peel will be soaked in another boiling solution of sodium bicarbonate ($NaHCO_3$) for 15 min and rinsed three times then dried (Zzaman *et al* ., 2013).

Ash gourd peel: - The Ash gourd will be thoroughly washed to remove sand particles after it will be sliced using a knife. The peel will be carefully scraped (Sudhaakr *et al*., 2017). Peel will be cut into approx 2×2cm pieces. The pieces will be blanched at 90˚C for 5 minutes then dried (Dhakal and Pradhananga, 2017).

1.3 Drying of the peels

The fruit and vegetable peels will be cut into small pieces, kept in stainless steel trays electrically operated hot air oven at specified temperatures 50^0C for 24 hour or till the constant weight achieve (Al-Sayed and Ahmed, 2013).

1.4 Processing of the dried peels:

The dried peels will be ground to powder using a grinder and further sieved through a 355-µm mesh sieve. The obtained selected fruit and vegetable peels flour will be stored in small – small plastic polybags or ziplocks for one time use. All the polybags or ziplocks will be vacuum packed (Zzaman *et al*., 2013)

PHASE 2:- QUALITY ANALYSIS

2.1 Proximate composition analysis of all the peel powder

Proximate composition of peels powder will be subjected to determine the moisture, ash, crude fiber, crude fat, crude protein, carbohydrate and total energy content according to the standard protocol (AOAC, 2016).

NUTRIENT	METHODS	REFERENCES
Moisture (g/100g)	Oven drying method	AOAC,(2016)
Ash (g/100g)	Dry ashing method	AOAC,(2016)
Crude Fiber (g/100g) (soluble and insoluble both)	Acid Alkali Wash method	AOAC,(2016)
Crude Protein (g/100g)	Micro Kjeldahl method	AOAC,(2016)
Crude Fat (g/100g)	Soxhlet Extract method	AOAC,(2016)
Carbohydrate (g/100)	Composite method	AOAC,(2016)
Energy (Kcal/100g)	By Calculation	

2.2 Analysis of Antioxidant Activity

METHOD	REFERENCES
DPPH (1,1-diphenyl-2-picrylhydrazyl) assay	Zulkifli *et. al,* (2012)

2.3 Analysis of the pesticide residues in watermelon peel, custard apple peels jackfruit peel and ash gourd peel powder.

2.4 Analysis of the functional properties of fruit and vegetable peel powder

Functional Properties	Methods	References
Bulk density	Okaka Method	(Menon ,2014)
Water absorption capacity	Grewal And Sood Method	(Menon ,2014)
Oil absorption capacity	Grewal And Sood Method	(Menon ,2014)
Swelling power	Sedimentation Method	(Yatnatti ,2017)

2.5 Shelf Life Analysis of Selected Fruits and Vegetable Peels Powder

Methods	References
SPC (Standard Plate Count)	Cappuccino & Sherman, 2014
TCC (Total Coliform Count)	Cappuccino & Sherman,2014

PHASE 3:- Development of value added products by incorporating peels powder for all age group :-Two products will be developed by adding each peel powder in different proportions. The peel powder will be substituted for basic ingredient in the variation of 10:90, 20:80, 30:70, 40:60 and 50:50.

3.1 The products selected are – baked *chakli* and baked *papdi*

3.2 Sensory evaluation of the developed products

Value added product developed by incorporating the peel powder of selected fruits and vegetables will be analyzed for sensory characteristics on a Hedonic Rating Test by semi-trained panel of 8-10 judges. The recipes will be tested on a 9 point scale ranging from 'extremely like' to 'extremely dislike'. The panelist will be selected by sensitivity threshold test.

PHASE 4:- Cost analysis of the highly acceptable product

Cost analysis of the highly acceptable product developed from each peel powder ie. from watermelon, custard apple, jackfruit and ash gourd will be calculated according to the latest market

7.FACILITIES AVAILABLE AT THE PLACE OF WORK

S.NO.	NAME OF EQUIPMENT	MAKE
1	Refrigerator Double Door	LG
2	Gas burner 4 gas	FABER
3	Hand Blender	INALSA
4	Food Weighing machine	RAJASTHAN SURGICAL SUPPLY
5	Spectrophotometer	SYNTRONICS
6	KEL PLUS (Nitrogen Digestion System)	Model KE: 04L (Digestion unit) Model: Elite GC Distillation
7	SOCS PLUS	Model: SCS-4 (Pat Echoector)
8	FIBRA PLUS	Model: FES-02
9	Physical Balance	JEEVAN NAGJI & CO.
10	Moisture Analyzer	MODELS: TMA-TOSHNIWAL AND CO.07.
11	Digital Electronic Balance	SARTORIOUS GERMANY , CAT NO. BSA224
12	Hot Air Oven	MAC MODEL OVD95 (SAD)
13	Muffle Furnace	MAC MODEL METI-12
14	Centrifuge Machine	REMI MODEL R-8C
15	Seed Germinator Plus	LCDS No 2555

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APPENDIX

SPECIMEN EVALUATION CARD FOR HEDONIC RATING TEST

NAME :…… DATE :…….

PRODUCT :……

Taste these samples and check how much you like or dislike each one. Use the appropriate scale to show your attitude by checking at the point that best describes your feelings about the sample. Please give a reason for this attitude. Remember you are the only one who can tell what you like. As honest expression of your personal feelings will help us.

	CODE	CODE	CODE
Like Extremely			
Like Very Much			
Like Moderately			
Like Slightly			
Neither Like Nor Dislike			
Dislike Slightly			
Dislike Moderately			
Dislike Very Much			
Dislike Extremely			
Reason			

Signature :…….

(Srilakshmi, 2016)